FARMING A CLIMATE CHANGE SOLUTION

Farmers have a golden solution to global warming largely missed by climate change pundits, right beneath their feet. The innovative Australian Soil Carbon Accreditation Scheme is showing how incentive payments can be received by landholders for measurable increases in soil carbon that soaks up CO_2 from the atmosphere. Financial incentives could help fund soil restoration efforts, which in turn bring the bonus of greater productivity, drought resilience and even rain. The action is deep underground.

Australian soil scientist Dr Christine Jones is frustrated that the world hasn't fully cottoned on to the important role of healthy crop roots and soils to draw down massive amounts of carbon, buffer drought and re-supply essential nutrients which have been drained from our landscape and farm produce by traditional agricultural practices.

Her 10-year crusade to raise the profile of soil carbon processes and what she calls the microbial 'carbon highway' led to the foundation of the organisation Amazing Carbon and then to the development and leadership of the Australian Soil Carbon Accreditation Scheme (ASCAS).

ASCAS is a vehicle to demonstrate through farm trials that with biologically based protocols involving perennial (long lived) deep-rooted pastures and annual crops, measured increases in vital soil carbon can be achieved quickly and rewarded with incentive payments for the CO_2 sequestered. The scheme is the first of its kind in the Southern Hemisphere, making Australia an early leader in the recognition of soils as a verifiable carbon sink.

By increasing soil carbon through biologically based techniques, Australian farmers can benefit the environment and their budgets. Malcolm Paterson, CSIRO

The ASCAS project is also collecting much needed hard data on soil carbon accumulation rates across various properties and soil types in the Northern Agricultural Region (NAR) of Western Australia and central Queensland, two of the areas hardest hit by climate change.

After the oceans, the soil is the earth's largest carbon sink – but plants are the facilitators. Through photosynthesis plants convert CO_2 to sugars to power growth, releasing oxygen into the atmosphere. The activities of symbiotic bacteria and fungi, associated with roots and fed by the sugars, enable the exuded carbon to be combined with soil minerals and made into stable humus[1] which locks the carbon away.

The fundamental processes which produce humified soil carbon are part of the microbial bridge – the focus of Dr Jones' interest – and the key to the formation and maintenance of healthy topsoils with high moisture-holding capacity, which largely determine plant and crop productivity.

'This can't happen where farm chemicals kill the essential soil microbes,' says Dr Jones. 'When chemical use is added to intensive cultivation, which exposes and oxidises the humus already in soil, it is easy to see why soil has become a huge net source rather than a net "sink" for atmospheric CO_2 under current farming practices.'

Alongside this, the removal of groundcover interrupts the important water and climate cycles facilitated by plants. Photosynthesis is a cooling process. Lack of green cover on the land greatly increases heat absorption, causing a dramatic increase in evaporation. Water vapour is a greenhouse gas of greater significance for global warming than CO_2. Lower rainfall can also result from groundcover loss.

Under conventional cropping practices, soil carbon in Australia has declined to one-half to one-third of original levels. CSIRO research has found that the rate of carbon sequestration resulting from good continuous pastures is enough to maintain

1 Humus may exist in soils for between 100 and over 1000 years, depending on conditions.

A duster applies fungicide to a crop at Virginia in South Australia. While they convey short-term benefit, the application of chemicals to farm soils harms their function and fertility over the long term, causing the release of carbon. Greg Rinder, CSIRO Land and Water

Carbon-poor farmland after rain (right), showing waterlogging due to poor structure. The denser groundcover of the adjacent stock route (left) results in higher soil carbon, better structure and improved water-holding capacity. Patrick Francis, *Australian Farm Journal*

or increase soil carbon levels, but all other crop/pasture rotations cause a decline of surface soil carbon.

Dr Jones claims that conventional approaches to modelling soil carbon, while useful for describing soil carbon loss, are inadequate for determining soil carbon gain. Soil carbon models such as Roth C do not take into account humification of root exudates or contributions from mycorrhizal fungi. 'Sequestration rates under regenerative agricultural regimes may be quite a bit higher than estimated by current models,' she says.

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Tim Wiley, Development Officer with Western Australia's Department of Agriculture and Food, was quick to realise the great potential of soil carbon increases with perennials. Wiley has been supporting the ASCAS trials in the NAR of WA. 'The trend is clear – perennial pastures sequester 5 to 10 tonnes of CO_2 per hectare annually.' He says with changes to farming practice, landholders in the northern agricultural areas of WA could sequester these amounts of CO_2 over two million hectares of poor sandy soil.

'If all WA's agricultural soils were sequestering carbon, we would soak up WA's current emissions. This would have the potential to significantly decrease Australia's net emissions and meet our Kyoto obligations.'

Add in the rest of Australia's agricultural land area – and the world's – and the impact on global CO_2 levels is evident.

Wiley pointed to current cost and data limitations to quantitative measurements of soil carbon. 'We don't know enough about carbon under different farming systems,' he said. 'We have data from farmer sampling before and after perennials were planted and over-the-fence comparisons, but it is not rigorous enough.

'To trade carbon we need a working model such as Roth C for estimating changes in carbon. The model results would be verified by occasional soil sampling of farmers' paddocks. Roth C needs to be validated with data from long-term trials in the regions that accurately measure carbon.'

That's where the ASCAS trials are filling in the picture.

Up at Lancelin, about 140 km north of Perth, things have been tough during the last 10 years of below-average rainfall. But cattle farmer Bob Wilson hasn't been too fazed; since changing his farming system over the past 20 years from traditional annual pastures to the fast-growing fodder shrub, tagasaste, and subtropical perennial (permanent) grasses, his farm has ridden out the dry far better than most, producing good returns.

As a member of the Evergreen Farming Group, he hasn't been surprised by the exciting results of the ASCAS trials. His band of farmers advocates growing hardier perennial plants which improve the soil and help stave off salinity. Two decades ago the view to the future of farming opened up for Wilson and his colleagues, and it looked much greener.

Unlike some of the other farmers involved in the ASCAS trials, Wilson has been growing perennials for some time. Using the scheme's protocols he has been able to measure soil carbon on his land and quantify to some extent how it can improve yields, increase water and nutrient retention for greater farm vigour, and now, potentially bring useful credit income for sequestering carbon dioxide.

He now has half his 2000 ha under tagasaste in wide rows with annual pastures in between. 'I changed my farming system because of concern for the environment, wind erosion and our need for an extended grazing season. We have doubled our carrying capacity.'

A cow browses one of many rows of tagasaste planted on Bob Wilson's property at Lancelin, WA. Bob Wilson

Department of Primary Industries and Fisheries Extension Agronomist Stuart Buck and Principal Technical Officer Maurie Conway drill sample soil cores as part of ASCAS trials north-east of Clermont in central Queensland. Testing is repeated in the same place each year to determine annual changes in soil carbon content. The soil under this crop contained over 3% carbon at the surface and 4% total carbon at 110 cm. Christine Jones, ASCAS

Carbon-rich topsoil from beneath perennial grass (left hand) compared to adjacent carbon-poor soil (right hand). By holding more air, sustaining moisture and having higher bioavailabilities of soil nutrients, carbon-rich soils benefit plants and soil biota. Courtesy Lucy House, 'Anabank', Baralaba

Plant roots provide habitat for soil biota and exude carbon, both of which are important for humification and soil-carbon stabilisation. Continuous grazing stunts grass root systems (left), which are more robust under rest-rotation grazing (right). Christine Jones, ASCAS

But he points out that while subtropical perennials provide an extended period of green feed, they grow slowly during winter and are susceptible to frosts. 'We need annuals as well for winter feed. A mixture of pasture types is best, on a case by case basis,' he says.

When Tim Wiley dug soil pits in Bob Wilson's paddocks, he found perennial-grass roots at the bottom of a 2.5 m deep pit and tagasaste roots at the bottom of a 3 m pit. He calculated from the soil test and other results that the perennial grasses and tagasaste were sequestering 7 t/ha of CO_2 per year more than traditional annual pastures.

The group of 12 farmers involved in ASCAS 'benchmarking' in the Northern Agricultural Region of WA over the last year will later in 2008 be completing calculations to see how much carbon has been sequestered under their perennial pastures. Baseline soil carbon levels in five increments in the 110 cm soil profile were determined during August 2007 within Defined Sequestration Areas on their properties.

Results from the first 12 months of field trials in Queensland will also be known later this year. Dr Jones says the initial findings have been exciting. 'One of the broadacre cropping properties north-east of Clermont in Queensland that is participating in the ASCAS project has more than three times the amount of carbon in the farmed soil than there is under the surrounding native vegetation (149 tonnes of carbon/ha under native vegetation versus 516 tonnes of carbon/ha under the crop). As a result, the soil is far more productive. The wheat crop yielded 4 tonnes per hectare of grain with 13.5 per cent protein this year – well above the district average.

'This demonstrates that with the right kind of farming (in this case zero till with microbial stimulants in place of harsh fertilisers) we can dramatically improve soil health. I'm not saying we should replace native vegetation with farmed land – far from it. What I am saying is there is still hope for much of the land that we have inadvertently almost totally destroyed,' she observes.

Under the Australian Soil Carbon Accreditation Scheme, participating farmers will receive Soil Carbon Incentive Payments (SCIPS) calculated at one-hundredth the 100-year rate ($25 per tonne CO_2 sequestered).

The incentive payments made to farmers are a private donation from Rhonda Willson, Executive Chairman, John While Springs (S) Pte Ltd and Director, Gilgai Australia.

Receipt of Soil Carbon Incentive Payments will be similar to being paid 'on delivery' for livestock or grain, with the bonus being that sequestered carbon remains in soil, conferring multiple landscape health and productivity advantages.

Agricultural soils have short-, medium- and long-term potential to mitigate climate change by sequestering atmospheric carbon as beneficial humified organic matter. Results from overseas studies indicate that the carbon sequestration potential of appropriately managed farmlands can be higher than that of tropical forests. In countries such as Brazil, Colombia, Costa Rica, Mexico and Cuba, the science of soil carbon is the subject of active research and development.

Dr Jones says the rationale for the ASCAS trials was to demonstrate that

Dr Christine Jones is advocating more focus on the role of soil carbon mechanisms in restoring landscapes and sequestering atmospheric carbon. David Elkins, UNE

significant quantities of soil carbon could be sequestered on Australia's commercial properties, even under difficult environmental conditions, provided appropriate land management technologies were employed.

Apart from needing to be rapid, stable and applicable to large areas, soil carbon sequestration as an effective climate mitigating tool must involve low-cost, easily implemented, innovative land management techniques that differ substantially from 'business as usual'. There also needs to be effective monitoring, evaluation and verification, particularly when measures of carbon sequestered might be linked to a financial mechanism.

At present an emissions trading scheme does not operate in Australia, although a national scheme is planned in line with the government's recent ratification of the Kyoto accord. Rio Tinto Coal Australia is currently one of the organisations funding research into soil carbon and its potential for a future carbon trading scheme under ASCAS.

Recent good news is that Australian agricultural products company Incitec Pivot Ltd has also come on board as a supporter of the Queensland field trials.

Of the estimated 3060 gigatonnes of carbon in the terrestrial biosphere, 82 per cent is in soils.[2] That's over four times the amount of carbon stored in the world's vegetation. Dr Jones asks, 'If only 18 per cent is stored in vegetation, why all the emphasis on biomass, rather than soil, as a carbon sink?

'The answer is that people – including most of our top scientists – simply don't understand soil carbon sequestration or the role of the microbial bridge and have therefore overlooked it.

'ASCAS was established so that farmers could receive incentive payments for increases in their soil carbon. We're demonstrating the incredible rates at which carbon can be put into soil by roots in biologically based sustainable cropping and grazing systems,' she says.

'Effective soil carbon management is a key factor for productive farms, revitalised catchments and a greener planet.

'Incentive payments for regenerative land management would help to "cash flow" the multiple natural resource management and environmental benefits that accompany increased levels of carbon in soils.'

● **James Porteous and Frank Smith**

More information:
ASCAS, www.amazingcarbon.com
Evergreen Farming Group, www.evergreen.asn.au

2 Lal R (2004). Soil carbon sequestration impacts on global climate change and food security. *Science* **304**, 1623–1627.

Note: The online version of this article has been modified from the print edition.